BISS Biodiversity Information Science and Standards

Biodiversity Information Science and Standards 9: e181234
doi: 10.3897/biss.9.181234

OPEN ACCESS

Conference Abstract

Towards a Common Language for Digital Specimens: Exploring the openDS Data Model

Wouter Addink[‡,§], Sam Leeflang[§,‡]

‡ Distributed System of Scientific Collections - DiSSCo, Leiden, Netherlands
§ Naturalis Biodiversity Center, Leiden, Netherlands

Corresponding author: Wouter Addink (wouter.addink@naturalis.nl)

Received: 03 Dec 2025 | Published: 05 Dec 2025

Citation: Addink W, Leeflang S (2025) Towards a Common Language for Digital Specimens: Exploring the openDS Data Model. Biodiversity Information Science and Standards 9: e181234.
https://doi.org/10.3897/biss.9.181234

Abstract

The accelerating decline of biodiversity demands urgent action to mobilise and connect the knowledge held in natural science collections. These collections represent centuries of accumulated specimen-based evidence, offering traceable and historical information essential for scientific discovery, conservation, and policy. Yet despite decades of progress in digitisation, the majority of specimen information remains inaccessible, through lack of digitisation or fragmentation across institutions and data silos. Coordinated collaboration, shared infrastructure and industrialisation of digitisation with help from machines, are needed to unlock the full potential of these resources at the scale, required to address global biodiversity challenges.

The Distributed System of Scientific Collections (DiSSCo) is designed to meet this challenge. By bringing together institutions, expertise, and services across Europe, DiSSCo aims to provide a unified platform where both humans and machines can collectively work on enhancing, linking, and curating specimen data (Koureas et al. 2018). Central to this vision is the need for a **common, comprehensive and extensible data model** that can handle the diversity and complexity of specimen-related data and metadata, support interoperability across systems, ensure long-term accessibility of data, and compliance with FAIR (Findable, Accessible, Interoperable, Reusable) Digital Object (FDO*[1]) principles to support machine actionability.

© Addink W, Leeflang S. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

For this, DiSSCo has developed the **open Digital Specimen (openDS)***[2] specification. It is an all-encompassing framework for describing, linking, and preserving digital representations of physical specimens (Hardisty et al. 2019). Unlike isolated schemas developed for specific domains, openDS functions as a shared language across the diverse service providers and communities, not only contributing to DiSSCo, but globally and across domain boundaries. It provides the flexibility needed to represent any type of specimen-related (meta-)data while embedding mechanisms for persistent identification, versioning, annotation, and provenance.

The design of openDS builds on a strong foundation of existing community standards and persistent identifiers. It extends and integrates TDWG (Biodiversity Information Standards) standards, including Darwin Core, the Chronometric Age extension, and Audiovisual Core, while also incorporating broader semantic web standards such as Schema.org, World Wide Web Consortium (W3C) Web Annotation, and the PROV Ontology (PROV-O). In this way, openDS can be regarded as an implementation*[3] of the **Darwin Core Conceptual Model***[4], ensuring **lossless data transfer** to and from Darwin Core Data Packages (DwC-DP). This interoperability guarantees that institutions adopting openDS can continue to align with widely used biodiversity data standards while benefiting from new capabilities provided by FAIR Digital Objects and DwC-DP.

In 2024, openDS underwent a public community review *[5] coordinated by DiSSCo, to collect feedback from biodiversity information experts worldwide. Since December 2024, openDS has been the basis of the **DiSSCo Digital Specimen data infrastructure**, underpinning key services such as Digital Specimen Digital Object Identifier (DOI) assignment, metadata integration, and interoperability with collection management systems and data infrastructures. By using FDOs, openDS ensures that each digital specimen is not merely a static record but a dynamic, citable, versioned, and machine-actionable object that can be enriched and reused across research workflows.

The structure of openDS reflects the complexity and richness of specimen data. The model consists of eight top-level classes*[2] , complemented by a set of generic nested classes and hundreds of terms that together cover a wide range of specimen attributes, contextual information, and derived data. While this richness may initially appear daunting, it is precisely what enables openDS to accommodate the diversity of natural science collections, from herbarium sheets, fossil specimens and rock samples to genomic extractions and environmental samples. The minimum information for what constitutes a “Digital Specimen” is described by the (draft) MIDS (Minimimum Information about a Digital Specimen) standard (Haston and Chapman 2022). Through careful alignment with FAIR principles and added semantics, openDS also ensures that digital specimens can be linked to a wide variety of related digital resources, including digital media, DNA sequences, publications, ecological observations, and nanopublications.

By adopting openDS, DiSSCo is not only enabling a pan-European integration of natural science collections but also contributing to the global conversation on how best to structure, govern, and sustain FAIR Digital Objects for science. The model exemplifies how community standards can be extended and harmonised into a framework that

supports both human curation and machine-actionable, AI-supported workflows. For biodiversity researchers, this means improved access to specimen information including provenance about data changes, persistence, and citability of specimen data. For institutions, it provides a sustainable pathway to align local digitisation efforts with international infrastructures and standards to improve data quality and data access.

In the conference we present the open Digital Specimen model, describe its design principles and foundations in community standards and use cases, and illustrate how it implements FAIR Digital Objects in practice. By guiding participants through the structure of openDS and demonstrating its role in linking collections, data infrastructures, and research, we aim to show how this new model contributes to a future where digital specimens play a key role in enhanced access to specimen data by researchers.

Keywords

FAIR data, Darwin Core, DiSSCo, biodiversity informatics, standards

Presenting author

Sam Leeflang

Presented at

Living Data 2025

Acknowledgements

We would like to acknowledge Alex Hardisty for creating the foundations for openDS, the DiSSCo development team at Naturalis, and everybody else in the DiSSCo and Biodiversity Information Standards (TDWG) community who contributed to openDS. Also we would like to acknowledge Tim Robertson from the Global Biodiversity Information Facility (GBIF) Secretariat for the collaboration on aligning openDS with the GBIF unified model and DarwinCore DP.

Hosting institution

Naturalis Biodiversity Center

Conflicts of interest

The authors have declared that no competing interests exist.

References

- Hardisty A, Ma K, Nelson G, Fortes J (2019) 'openDS' – A New Standard for Digital Specimens and Other Natural Science Digital Object Types. Biodiversity Information Science and Standards 3 https://doi.org/10.3897/biss.3.37033
- Haston E, Chapman C (2022) MIDS: The digitisation standard for Natural Science collections. Biodiversity Information Science and Standards 6 https://doi.org/10.3897/biss.6.94604
- Koureas D, Addink W, Hardisty A (2018) Digital Object Cloud for linking natural science collections information; The case of DiSSCo . Biodiversity Information Science and Standards 2 https://doi.org/10.3897/biss.2.25474

Endnotes

*1 https://fairdo.org/basic-fdo-definition/

*2 https://terms.dissco.tech

*3 https://github.com/DiSSCo/openDS

*4 https://gbif.github.io/dwc-dp/#cm

*5 http://dissco.tech/2024/07/25/opends-public-review/